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S-IVB STAGE STORAGE PLAN

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ABSTRACT

The storage plan for the Saturn S-IVB stages presents the requirements for storing stages, APS modules, and ancillary flight hardware. Specifically described in the plan are space (facilities) requirements, environment, storage equipment, preservation methods, preparation for storage, storage, removal from storage, and test requirements for recertification. The plan covers storage of stages prior to static firing and following static firing.

DESCRIPTORS

S-IVB Stage Storage
Preservation Methods
Storage Facilities
Storage Equipment
Post-Storage Certification
Post-Storage Testing
Post-Storage Inspection
Post-Storage Refurbishment
Post-Storage Reconfiguration
Storage at Sacramento Test Center (STC)
Storage at Florida Test Center (FTC)
Storage at Huntington Beach (HB)

PREFACE

The purpose of this plan is to establish the requirements to store Saturn S-IVB stages and their associated stage flight equipment. It also describes refurbishment, retests, calibration, and tests that are required for certification of the S-IVB stage and its associated flight equipment necessary for a flight operational reliable condition following storage. The technical requirements described in this plan satisfy the design criteria of Standard MSFC-STD-496.

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ILLUSTRATIONS

Gamma Complex	Test area for APS and ancillary hardware, STC
GSE	Ground Support Equipment
H&CO	Handling and Checkout (drawing)
HB	Huntington Beach
KSC	Kennedy Space Center
LUT	Launch Umbilical Tower
MDAC-WD	McDonnell Douglas Astronautics Company - Western Division
MP	Maintenance Procedure
MSFC	Marshall Space Flight Center
NDSE	Nondeliverable Support Equipment
OAT	Operational Acceptance Test
PMP	Preventive Maintenance Program
PPM	Parts Per Million
PU Assembly	Propellant Utilization Assembly
R&D	Research and Development
S-IB	Saturn IB Vehicle
S-IVB/S-IB	S-IVB stage of the Saturn IB Vehicle
S-IVB/S-V	S-IVB stage of the Saturn V Vehicle
S-V	Saturn V Vehicle
SIM	Safety Item Monitor
SSB	Single Sideband
STC	Sacramento Test Center
T/M	Telemetry
VAB	Vehicle Assembly Building (KSC)
VCL	Vehicle Checkout Laboratory

*NOTE: The ancillary flight hardware for the purposes of this Plan are as follows:

Item	Includes
Aft Interstage	Aft Interstage
	Aft Interstage Hardware Procurement Kit
	Hazardous Gas Detection System

1. INTRODUCTION

The Saturn S-IVB Stage Storage Plan contains the procedures and establishes the requirements to store S-IVB stages, Auxiliary Propulsion System (APS) modules, and ancillary flight hardware. It also contains the post-storage requirements necessary to certify or recertify that stored stages and associated flight equipment have been returned to a flight operational reliable condition.

1.1 Scope

The Stage Storage Plan, authorized by NASA Contract NAS7-101, Change Order 1233, covers storage periods for stages that are stored prior to, and following, static firing. The Plan is based on mated and demated inside storage of S-IVB stages and associated stage equipment at the Sacramento Test Center (STC), Huntington Beach (HB), and at the Florida Test Center (FTC).

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1.2 Abbreviations and Terms

The following list of abbreviations and explanation of terms is intended to aid in the evaluation of the Stage Storage Plan:

*Ancillary Flight Hardware	See note at end of list
APS	Auxiliary Propulsion System
AST	All-Systems Test
Beta III	Stage Test Stand, Beta Complex, STC
Beta Complex	Test area for stages, STC
C/O	Checkout
DDAS	Digital Data Acquisition System
DER	Digital Events Recorder
E/I	External/Internal
EBW	Exploding Bridgewire
EMC	Electromagnetic Compatability (test)
EO	Engineering Order
FTC	Florida Test Center

Ullage Rocket Hardware	Ullage Rocket Fairing, Nose Cover
	Ullage Rocket Motor
	Ullage Rocket Fairing Kit
	Ullage Rocket Fairing Installation Kit
	Ullage Rocket Instrumentation Kit
Explosive Kits	EBW Detonator Kit
	Separation System Kit
	Ullage Rocket Jettison Kit
	Propulsion Dispersion System Kit
	Safe and Arm (S&A) Kit
	Retrorocket Ignition Kit
	Ullage Rocket Ignition Kit
Retrorocket Hardware	Retrorocket Motor
	Attachment Kit
	Instrument Kit
Miscellaneous Hardware	Thermoconditioning System Supply Hose Kit
	Plume Impingement Wire Harness Protection Kit
	Emissivity Control Electronic Component Kit

1.3 List of Referenced Documents

The following documents are referenced in the Stage Storage Plan:

NASA Contract NAS7-101, Change Order 1233

MSFC-STD-492, Closed-Loop Hydraulic Systems, Long-Term Storage of

A.F. Explosive Safety Manual No. 127-100

MSFC-STD-105, Synthetic Rubber, Age Control of, Standard for

Stage Storage Procedure, VCL-SACTO, Douglas Drawing 1B67536

MSFC-STD-496, S-IVB Stage Storage, Standard for

Ordnance Safety Manual No. 11A-1-40

End Item Test Plan, S-IVB/S-IB Stage, Douglas Drawing 1B66532

End Item Test Plan, S-IVB/S-V Stage, Douglas Drawing 1B66684

J-2 Rocket Engine Maintenance and Repair Manual R-3825-3, Volume 1
Contract Data Requirements, Saturn S-IVB Stage and GSE, MSFC-DRL-021
Saturn S-IVB Quality Control Plan, Douglas Report SM-41891
Narrative End Item Reports (NEIR)
S-IVB Stage Logistic Program Plan, Douglas Report SM-46669
Douglas Finish Specification F-289
MIL-D-3716, Desiccants, Activated, for Dynamic Dehumidification

2. STAGE, APS, AND ANCILLARY FLIGHT HARDWARE STORAGE

2.1 General

The Stage Storage Plan contains the requirements for storing S-IVB stages and their associated flight hardware. It also describes the requirements to remove the stages and associated flight hardware from storage and to assure that they are returned to a flight operational reliable condition and certified or recertified. The Plan describes requirements for stages stored following manufacturing checkout, but prior to static firing, and requirements for storage of stages following static firing.

The S-IVB stages will be stored indoors at HB and STC. Storage of S-IVB stages at FTC is not considered feasible and is not included in this Plan. Long term storage of stages and associated flight hardware is not recommended at FTC due to adverse environmental conditions, lack of MDAC-WD assigned and controlled storage facilities, and a general incompatability with normal work schedules and requirements. The APS modules will be stored indoors at STC or HB. Ancillary hardware will be stored at HB with the exception of explosives, retrorockets, and stage batteries. Ancillary explosive kits, manufactured by Douglas, will be stored at FTC in bunkers: ullage rockets, retrorockets, and stage batteries will be stored at the manufacturer or delivered directly to FTC and stored utilizing the present adequate facilities and procedures.

The Stage Storage Plan basically describes two storage periods; short term storage up to six months, and long term storage for six months or longer. Stages stored for periods up to six months will require a minimal effort for recertification which will include post-storage inspection and corrective actions necessary to repair any obvious detrimental storage effects. These activities are in addition to the normal stage phasing cycle.

It has been determined that if a stage is to be stored for periods longer than six months, environmental control requirements should be imposed to assure reasonable protection to the stage and stage equipment. The philosophy of the Storage Plan is to place the stage to be stored for long term storage in an environmental enclosure and an access controlled area. Once the stage has been placed in the enclosure, it will be considered "impounded" and no work will be performed until the stage has been removed from storage.

2.2 Documentation

2.2.1 Procedures

Detailed CEI storage procedures will be prepared in accordance with Contract Data Requirements, MSFC-DRL-021, Line Item 47, describing the procedures and defining the operations required to prepare the stage for storage, for maintaining the stage while in storage, and for removal from storage. The performance tests to be used as a post-storage check of stage systems will be specified in the applicable stage End Item Test Plan in accordance with MSFC-DRL-021, Line Item 139, and detailed in individual checkout procedures.

2.2.2 Reports

A storage status report covering all storage locations shall be submitted to MSFC quarterly. All storage activities and observed anomalies will be contained therein. The initial report shall indicate stage attitude.

2.2.3 Access Log

A storage activity log book shall be provided for each stage in storage. All activities that occur within the storage area during storage shall be recorded in the log book, i.e., identify all personnel admitted, work authorized, and activities accomplished. All personnel, equipment and R1 tools required to accomplish a job, and part numbered stage hardware shall be logged into and out of the storage area. The log book shall be clearly identified as a storage area log book and be conspicuously located at the entrance to the storage area. Significant entries in the storage activity log book will be included in the quarterly storage status report. The storage activity log book will be added to the applicable Stage Log Book upon termination of storage.

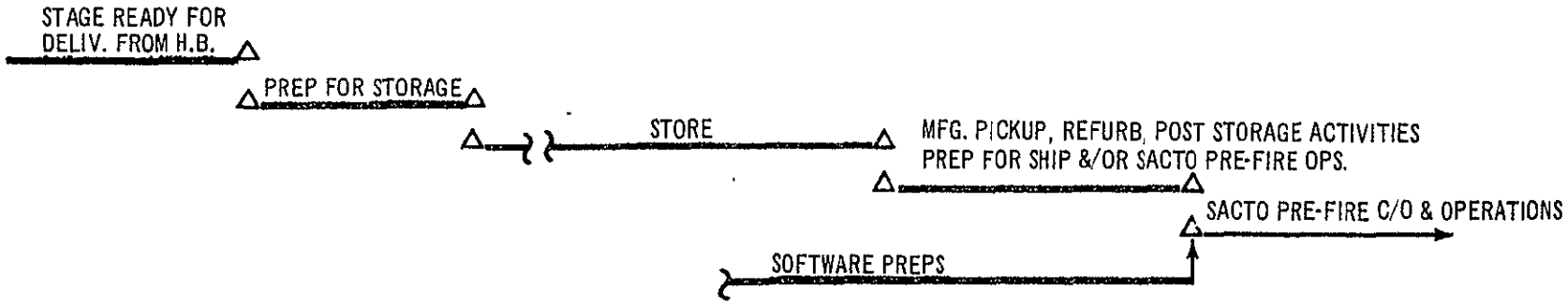
2.3 Stage Removal Times

Figure 1 provides a typical, comparative schedule for stages stored prior to static firing and for stages stored following static firing. It depicts schedules for stages stored for periods greater than six months only, as it has been determined that stages stored for less than six months will require a minimal checkout prior to stage turnover.

Stages stored for over six months, regardless of whether or not the stage was static fired prior to storage, will require a pre-test leadtime notification, prior to testing for certification or recertification. All stages stored for over six months will require a testing sequence after removal from storage. Testing philosophy and procedures are detailed in paragraph 17.

It is readily apparent that firm removal times for each stored stage can only be established by an individual analysis of the modification requirements, refurbishment, the stage storage configuration, the post-storage activities required by the actual storage period, the GSE test equipment and test stand recertification and/or reconfiguration requirements necessary to checkout the stage, and the normal manufacturing schedule impact on the test stand and test site activities.

1. **PRE-STATIC FIRE STORAGE**



2. **POST-STATIC FIRE STORAGE**

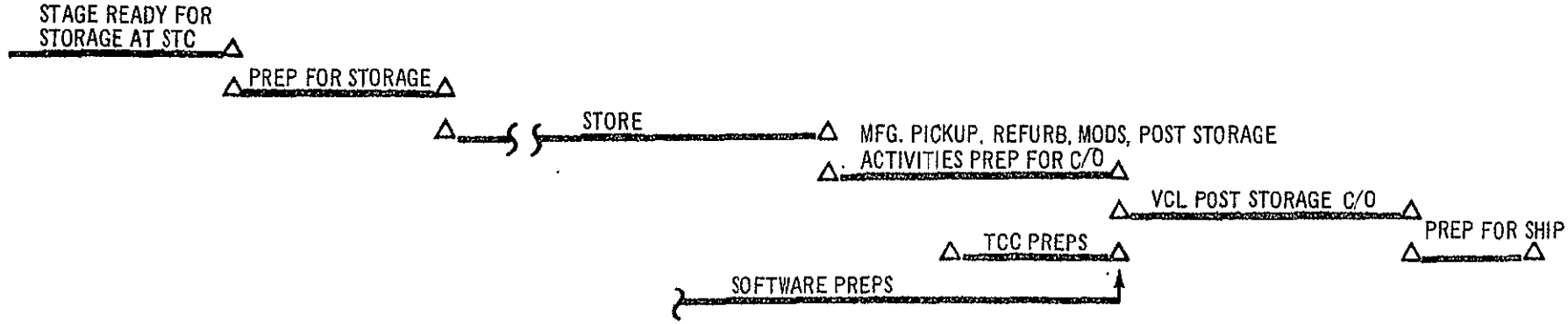


Figure 1. Typical Comparative Stage Storage Work Flow

3. STORAGE CONSTRAINTS

3.1 NASA Imposed Stage Storage Constraints

The following constraints to the Stage Storage Plan were imposed by direction of NASA Change Order 1233:

a. There will be no prolonged outside storage of the stage considered other than on test stands or launching pads.

b. All storage described in the Stage Storage Plan is considered as pure storage. No manufacture or modification work shall be done during the described storage period. The stage is considered to be impounded, with no cannibalism allowed.

c. Recalibration and recertification will be required after long term storage.

d. All refurbishment, modification, and/or reconfiguration will be accomplished after the stage and equipment have been removed from storage, but prior to shipment.

e. The Stage Storage Plan should describe storage techniques required to store stages prior to static firing, but after manufacturing checkout, and the requirements necessary to reinstate the stage into a normal test cycle.

f. The Stage Storage Plan should describe storage techniques required to store stages after static firing, but prior to post-static checkout, and the requirements necessary to reinstate the stage into a normal test cycle.

3.2 Douglas Imposed Stage Storage Constraints

The following constraints to the Stage Storage Plan are imposed by Douglas:

a. The aft interstage can be placed in long term storage without benefit of an environmentally controlled shelter.

b. Long term storage of stages at STC and HB, as described in the Stage Storage Plan, is based upon availability of existing facility capabilities.

c. Short term storage of stages at HB, as described in the Stage Storage Plan, is based upon existing facility capabilities on a contingency basis.

d. If stage storage space is required by NASA in addition to that provided by the Stage Storage Plan, Douglas recommends that additional temporary capabilities be provided at HB. This recommendation is based upon the rationale of having trained personnel available to monitor and inspect the stored stages, and the capabilities for incorporating modifications and repairs, if required at a later time.

e. The determination of GSE and NDSE quantity requirements, as specified in the Stage Storage Plan, is based upon the current manufacturing and test schedules, the maximum long term storage capability for stages at STC, the capability of interim storage of stages at HB, and the capability for supporting the existing launch schedule at FTC.

f. Additional GSE and NDSE requirements are noted in the Stage Storage Plan, and have been determined on the basis of activities necessary to support storage of stages and ancillary hardware.

g. No checkout, testing, refurbishment, or modification will be performed on the stored stages or stage components while in long term storage.

h. If it is pre-determined that a stage is to be stored for more than six months, the stage will not be static fired prior to storage.

4. DETRIMENTAL EFFECTS OF STORAGE

Detrimental effects of stage storage which could affect flight operational reliability were analysed for the following conditions:

a. Entrapment or condensation of moisture which could reuslt in corrosion.

b. Entrapment or condensation of moisture which could result in degradation of electrical and electronic insulation resistance.

c. Material deterioration which could result in loss of sealing qualities.

d. Material deterioration which could result in degradation or failure of electrical and electronic insulation.

e. Oxidation effects, particularly with respect to potentiometers, which could promote an increase in contact resistance resulting in a high noise level.

f. Diaphragm "set" in pressure transducers which could result from the diaphragm being subjected to near maximum pressure design limits for extended durations of time.

g. Surface and crevice corrosion, particularly in the forward skirt cold plate system, which could effect heat transfer capabilities, as well as pressure strength.

h. Stress corrosion of various high-strength torqued bolts and fasteners.

i. Storage effect on insulation and bonding in LH_2 and LOX tanks.

j. Possible loss of vacuum in LH_2 and LOX tank vent and relief valve vacuum reference bellows.

k. Calibration shifts due to long term degradation of electrical components.

l. The exceeding of age and shelf life of stage components and assemblies.

These analyses were based upon actual inspections of stages at STC and FTC, limited storage historical data, design criteria, and component and material specifications. As a result of these analyses, it was determined that stages stored under controlled environmental conditions as detailed in this document will significantly minimize detrimental effects on post-storage stage flight operational reliability.

5. STAGE SAFETY AND SECURITY

The safety and security requirements for stage storage consists of two objectives: the safety of personnel, and the security of the S-IVB stage and stage hardware.

5.1 Safety

The Employe Safety Department, in addition to assuring compliance with normal safety regulations, will participate with other departments (Operations, Development Engineering, Logistics, Maintenance, System Safety) to identify any new and/or unusual hazards and to develop appropriate safeguards.

S-IVB stage and stage equipment safety will be a prime consideration at all times during the stage storage period. All stage moves, storage space preparations, storage, and removal from storage will be controlled by documented procedures.

5.2 Security

Security requirements to support stage storage will consist of surveillance, access control, and accountability. The need for these monitoring and control activities is necessary to maintain a positive control of access to the stage and a formal accountability for all acts that may affect the condition or configuration of the product.

5.2.1 Surveillance

Surveillance of storage areas will be the responsibility of MDAC-WD supervision and assigned lead personnel during active working shifts, and of Security Police Officers (roving) during off shift periods.

5.2.2 Access Control and Accountability

The stored stages shall be under access control at all times. All avenues of access shall be locked, manned, or otherwise limited to personnel authorized to enter the storage area. An access log as described in paragraph 2.2.3 shall be provided.

Access control to the stored stages will be provided by the use of locked storage buildings or protective fencing that will require personnel to clear through an official checkpoint prior to entering the storage area. The checkpoint will establish:

a. Justification of need for access.
b. Verification of proper shoes and clothing.
c. Reason for entry by identifying operations to be performed.
d. Adequate knowledge of any local rules or operational controls for protection of the stage (hard hats, loose items in pockets, etc.).

All stages stored in open manufacturing areas will be surrounded by a six-foot high wire fence with lockable gates. The protective fence will be designed to be quickly and easily removed, in its entirety or in sections, in the event of need.

6. STORAGE PERIODS

The storage plan for the S-IVB stages and ancillary hardware is based on the following storage periods:

a. Up to six months.
b. Greater than six months.

The storage periods were determined as a result of analysis of the stage and ancillary hardware, structures, stage systems, subsystems, modules, and component parts to identifv storage requirements.

Electrical, electronics, telemetry, and hydraulic storage requirements had the greatest impact in determining the storage periods. As an example, the S-IVB stage can be stored up to six months without imposing additional requirements to a normal stage turnover cycle. After six months of storage, recertification requirements will include retests and tests of electrical, electronic, pneumatic, hydraulic, and telemetry systems.

7. STORAGE FACILITIES AND SPACE REQUIREMENTS

7.1 Storage Facilities

Facilities required for storage of the S-IVB stages are located at HB and STC; facilities required for storage of APS modules, ancillary hardware, and spare parts are located at STC, HB, and FTC.

Stages can be stored at the following locations, as indicated:

Stage Quantity	Location	Storage Mode
2	VCL North Bay, STC	Vertical
1	VCL North Bay, STC	Horizontal
2	Building 5, STC	Horizontal
1	Tower 7, HB	Vertical
*1	Building 45, HB (Typical)	Horizontal

*Capability for storing stages horizontally at HB is influenced by other program activities and cannot be pre-determined.

The quantity of stages that can be stored at HB and STC is based on existing facilities.

7.1.1 Sacramento Test Center Facilities

7.1.1.1 Stage Storage

At present, a total of five S-IVB stages can be stored inside the existing facilities at this location (Figure 2). The planned storage will include storing three stages in the VCL Building and two stages in the Manufacturing Support Building (Building 5). This can be accomplished by storing two stages vertically and one stage horizontally in the north bay of the VCL. The remaining two stages will be stored horizontally in the center of the Manufacturing Support Building.

Controlled access to the storage areas will be accomplished by securing the north bay of the VCL Building, and erecting portable, or easily removable

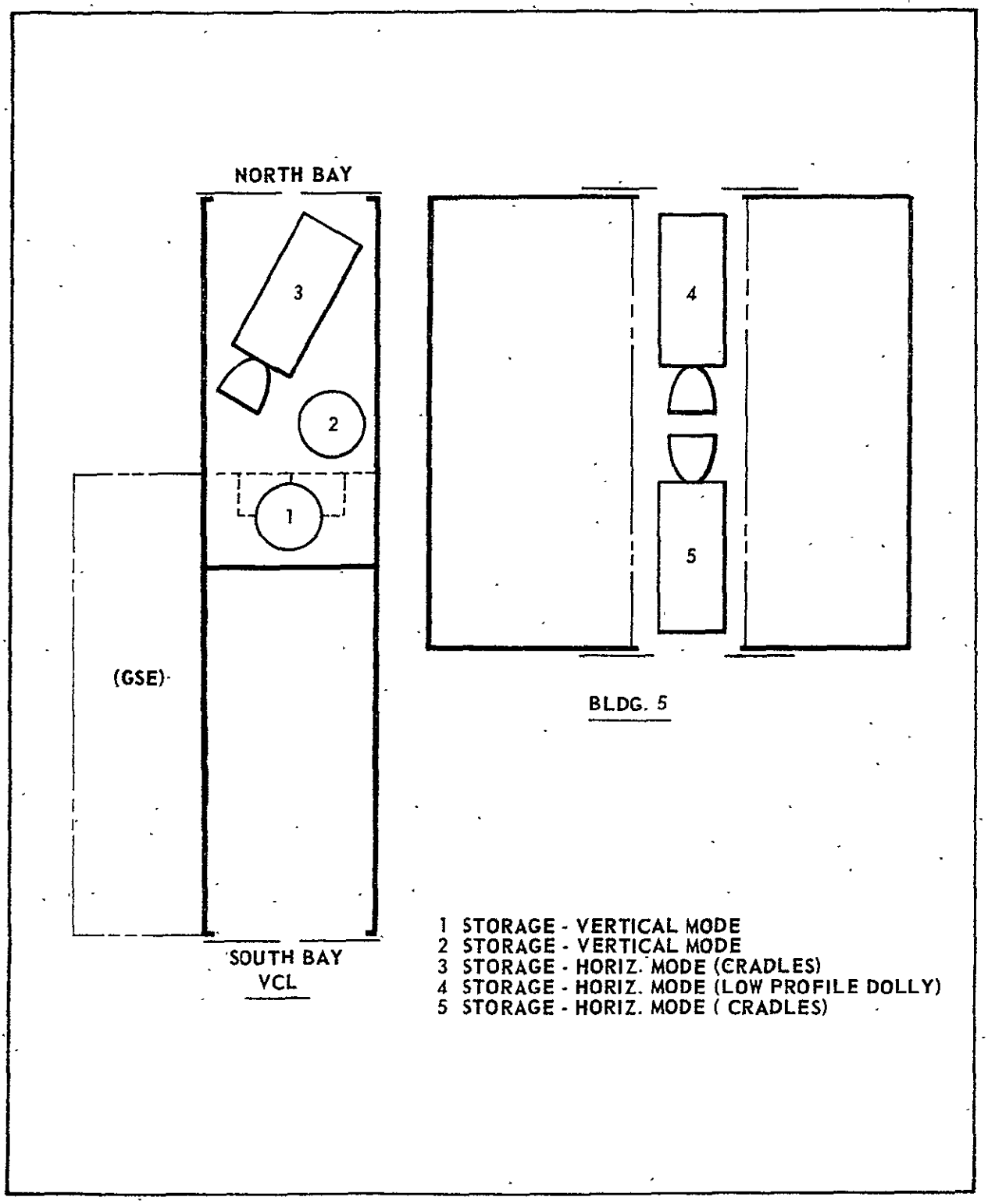


Figure 2. Storage Capability - Sacramento Test Center

six-foot chain link fences around the stages stored in the center section of the Manufacturing Support Building and the VCL storage area:

7.1.1.2 Ancillary Hardware

Presently, no capability exists at the Sacramento Test Center for inside or outside storage of ancillary hardware, including the aft interstages.

7.1.1.3 APS Modules

The APS modules, two required per stage, will be stored in the Manufacturing and Assembly Building, Unit 37, Gamma Complex.

7.1.2 Huntington Beach Facilities

7.1.2.1 Stage Storage

One S-IVB stage can be stored vertically in Tower 7 (Figure 3) at HB. Controlled access to the storage area will be accomplished by installing a portable, easily removable six-foot chain link fence at ground level, and securing the landings at the upper levels with fencing and locked gates on the common stairway between Towers 7 and 8. An additional storage position, if required, may be located in Building 45. Figure 3 shows a typical horizontal storage position. The availability of horizontal storage space at HB is influenced by overall MDAC-WD division plans and programs, and cannot be pre-determined.

7.1.2.2 Ancillary Hardware

The aft interstage can be stored in an outside area located north of Building 45, high bay, and west of the low bay extension to Building 45, as shown in Figure 3. This area can accommodate up to ten interstages. Storage in this area will require the use of suitable

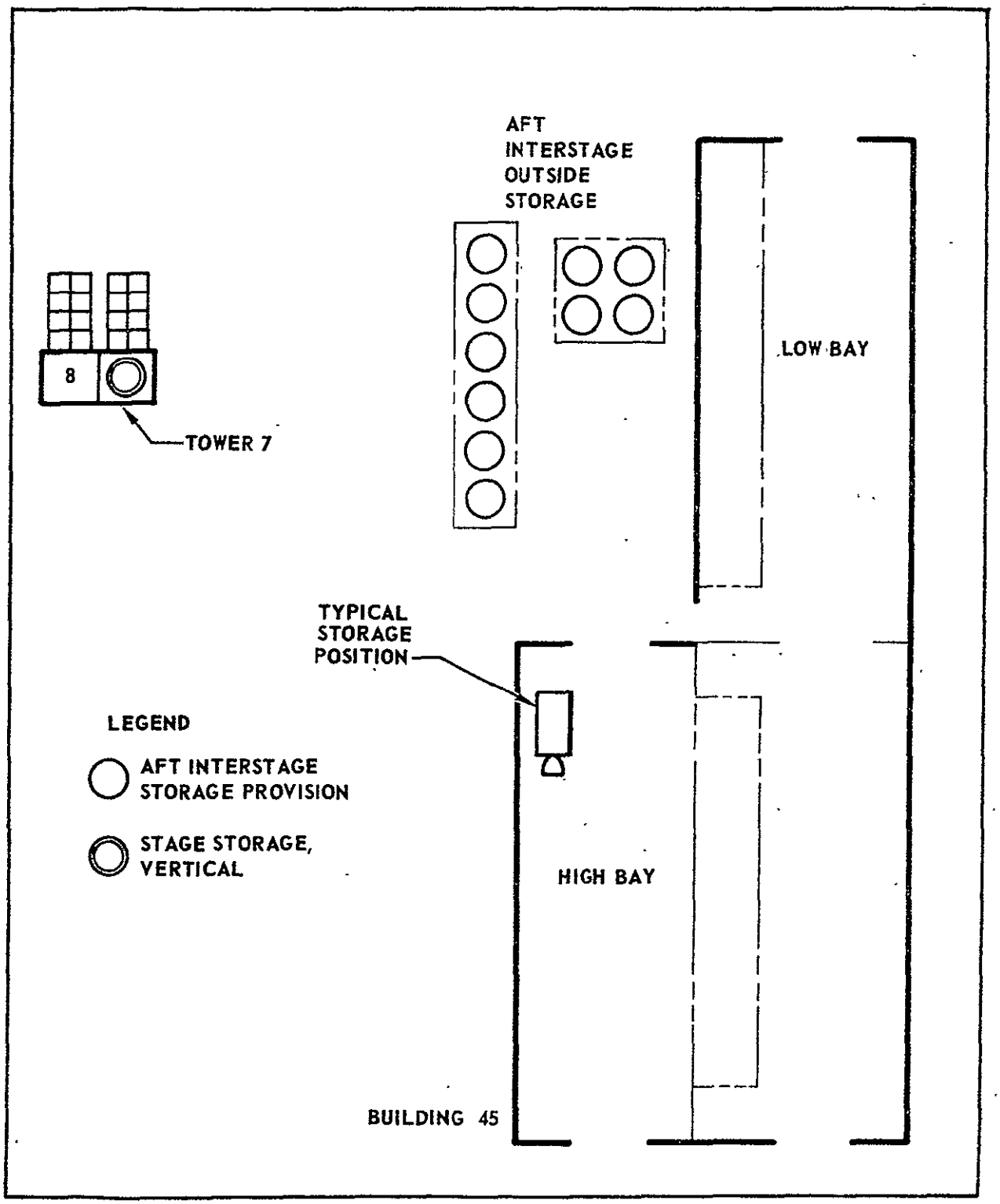


Figure 3. Storage Capability - Huntington Beach

protective covers, and adequate support and tiedown equipment. Access control to the stored aft interstages is not critical. A roped-off area with a restricted entrance will be sufficient.

R1 Existing facilities at HB cannot accommodate long term inside storage of aft interstages at this time. The aft interstages will be stored at Michoud Assembly Facility (MAF).

Ancillary hardware except ordnance items and batteries will be stored in Building 45. These items will require an access controlled area of approximately 500 to 600 square feet.

7.1.2.3 APS Modules

The APS modules will be stored indoors in an environmentally controlled area.

7.1.3 Ordnance Test Site

R1 Ordnance ancillary equipment (explosives kits) will be stored at a designated MDAC-WD site. They will be stored in compliance with the A.F. Explosive Safety Manual No. 127-100 and the Ordnance Safety Manual No. 11A-1-40.

Facilities will be made available for storage of ordnance for four stages. It is estimated that temporary additional bunkers will be required to provide additional storage for ordnance items in excess of four stages.

7.1.4 Florida Test Center

7.1.4.1 Ancillary Hardware

At present, MDAC-WD does not have facilities available for storage of aft interstages at FTC. However, if storage facilities are made available at FTC for storage of aft interstages, the space requirements are described in paragraph 7.2.

Space requirements for other ancillary hardware of seven stages, excluding ordnance items and batteries, will require an access controlled area of approximately 450 square feet in a sheltered and enclosed building. Ordnance items and batteries can be stored in existing MDAC-WD assigned facilities, which are adequate.

7.2 Storage Space Requirements

The space required for stage storage is determined by the mode of storage (horizontal or vertical), method of handling, and recommended access area around the stage for storage activities. The minimum storage area requirements for each stage are as follows:

Horizontal Mode Storage	- a minimum total inside volume of 40,000 cubic feet is required per stage to allow for general handling and access.
Vertical Mode Storage	- a minimum total inside volume of 44,000 cubic feet is required per stage to allow for general handling and access.
Aft Interstage Storage (S-IVB/S-IB)	- a total outside volume of 21,000 cubic feet is required per interstage for general handling and access.
Aft Interstage Storage (S-IVB/S-V)	- a total outside volume of 29,000 cubic feet is required per interstage for general handling and access.

8. ENVIRONMENTAL REQUIREMENTS

8.1 General

The S-IVB stages will be stored indoors in an environmentally-controlled enclosure. Static and dynamic environmental control equipment will be used to protect the fuel and oxidizer tanks, tank vent systems, forward and aft skirts, cold plate system (thermal conditioning panels), and the J-2 engine system of stages stored for periods of six months or more.

The dewpoints for the environmental control of the stage are based on the following parameters:

Location	Minimum Ambient Temperature of Drybulb
Huntington Beach	45°F
Sacramento Test Center	35°F

Ancillary hardware, excluding the aft interstages, will be stored indoors but will not require environmental control other than that environment provided by their shipping containers. Aft interstages will not require a controlled environment, but will require protective covers.

Storage handling and checkout procedures, similar to MDAC-WD Drawing 1B67536, Stage Storage Procedure, VCL-SACTO, will be provided to establish the environmental control requirements at each storage location.

8.1.1 Humidity

The environment of the stage storage enclosure shall not exceed 40 percent relative humidity, except as described in paragraph 8.1.4.

8.1.2 Temperature

The temperature of the stage storage enclosure shall not exceed 90 degrees Fahrenheit nor fall below 50 degrees Fahrenheit, except as described in paragraph 8.1.4.

8.1.3 Contaminants

The stage storage enclosure shall be certified at the beginning of the storage period, and at three-month intervals during storage, to be free of hazardous contaminants at least to the following levels: Ozone 0.15 PPM maximum, sulfur dioxide 0.10 PPM maximum, and chlorides 1.00 PPM maximum.

Air entering the enclosure will be filtered by a filter system which is capable of removing 90 percent of all particulate material of a size
R1 greater than 5.0 microns.

8.1.4 Control Range

Violations of the humidity, temperature, and contaminant requirements established in paragraphs 8.1.1, 8.1.2, and 8.1.3 can be tolerated over a continuous time span of not more than 36 hours, but in no event shall a dewpoint state be permitted to exist within the propellant tanks and associated systems.

8.2 Stage Environmental Control

Temperature and humidity of the storage environment shall not exceed the following values, except as described in paragraph 8.1.4.

8.2.1 Liquid Hydrogen and Liquid Oxygen Tanks

The storage environment for the LH_2 and LOX tanks and related ducting shall be between 50 degrees Fahrenheit and 90 degrees Fahrenheit and not exceed 40 percent relative humidity.

8.2.2 Forward and Aft Skirts

The storage environment for the forward and aft skirts and the stage center section shall be between 50 degrees Fahrenheit and 90 degrees Fahrenheit and not exceed 40 percent relative humidity.

8.2.3 Thermal Conditioning System

The storage environment for thermal conditioning coolant passages shall be between 50 degrees Fahrenheit and 90 degrees Fahrenheit and not exceed 40 percent relative humidity.

8.2.4 J-2 Engine

The J-2 engine will not be removed during storage of the S-IVB stage. Ambient relative humidity will not exceed 40 percent. The internal volume of the engine will be desiccated in accordance with the instructions contained in the J-2 Rocket Engine Maintenance and Repair Manual R-3825-3, Volume 1.

8.3 APS Environmental Control

The storage environment for APS modules shall be between 20 degrees Fahrenheit and 120 degrees Fahrenheit and will not exceed a relative humidity of 40 percent. The storage environment will be monitored and recorded to ensure that temperature and humidity requirements are adhered to. R1

8.4 Ancillary Hardware Environmental Control

8.4.1 Aft Interstage

The aft interstages will not require environmental control other than protective covers; however, covers must be installed in such a manner as to allow a free flow of air between the cover and the interstage.

8.4.2 Other Ancillary Hardware

Ullage rockets, retrorockets, explosive kits, and miscellaneous ancillary hardware will require inside storage in a clean, dry, ventilated environment. Prior to storage, these items will be packaged, as required, for protection against extreme temperatures, humidity, impact, and other environmental hazards which could damage the stored item and thereby degrade its performance capability. No special handling equipment will be required. These items can be stored on shelves, racks, or in bins within their assigned storage area.

9. STORAGE EQUIPMENT REQUIREMENTS

The storage equipment requirements consist of the GSE and NDSE items necessary to support long term storage of eight stages for periods up to three years in both the horizontal and vertical modes.

9.1 Equipment Required to Support Storage

The storage equipment requirements for stage storage consist of the GSE and Non-Deliverable Support storage in both the horizontal and vertical modes. R1

9.1.1 GSE Required to Place Stage Hardware in Protective Storage

9.1.1.1 Stage Storage at STC

The following GSE is required to store a maximum of five Saturn IB stages (three horizontal and two vertical):

Model DSV-4B	Nomenclature	Units Required
301	Stage Cradle Kit	3
302 or 462 or 1893	Stage Handling Ring Kit	5
310	Forward Access Kit, Vertical	2
365	Desiccant Kit, Secondary	5
392	Birdcage	2
450	Desiccant Kit, Static	4
797	L.T. Storage Kit, Horizontal	3
798	L.T. Storage Kit, Vertical	2
800	L.T. Storage Accessory Kit, STC	1
1888	Storage Equipment Kit	5
1889	Moisture Monitor Kit	1

In addition, the following GSE is required at STC for stage handling, movement, and preparation for storage:

Model DSV-4B	Nomenclature	Units Required
300	Stage Transporter	3
301	Cradles	2
303	Hoist Kit	2
305	Transporter Tool Kit	3
1865	Purge Kit	1
1891	Low Profile Dolly	1
1863	Roller Transfer Kit, Air Carry	1

9.1.1.2 Stage Storage at Huntington Beach

The following GSE is required to store a maximum of two Saturn IB stages:

Model DSV-4B	Nomenclature	Units Required
300	Transporter	2
301	Cradles (or tooling cradles)	2

Model DSV-4B	Nomenclature	Units Required
302 or 462 or 1893	Handling Rings	2
305	Transporter Tool Kit	2
310	Forward Access Kit	1
365	Desiccant Kit, Secondary	2
392	Birdcage	1
450	Desiccant Kit, Static	2
797	L.T. Storage Kit, Horizontal	1
798	L.T. Storage Kit, Vertical	1
799	L.T. Storage Accessory Kit, HB	1
1888	Storage Equipment Kit	1
1888A	Storage Equipment Kit	1
1889	Moisture Monitor Kit	1

In addition, the following GSE is required at Huntington Beach for stage handling, movement, and preparation for storage:

Model DSV-4B	Nomenclature	Units Required
300	Stage Transporter	1
301	Stage Cradle Kit	1
302 or 462 or 1893	Handling Rings	1
303	Hoist Kit	1
305	Transporter Tool Kit	1
1865	Purge Kit	1
1863	Roller Transfer Kit, Air Carry	1

9.1.1.3 Stage Storage at MSFC Huntsville, Alabama

The following GSE or support equipment is required to store Stage 1004. This equipment, now classified as rotational, will be transferred to NASA/MSFC by final DD 250.

Model DSV-4B	Nomenclature	Units Required
413A	Handling Rings	1
365	Desiccant Kit, Secondary	1
450	Desiccant Kit, Static	1
797	L.T. Storage Kit, Horizontal	1
1888A	Storage Equipment Kit	1
	Tooling Cradles	1

The following rotational type GSE, to be utilized in handling and preparation for storage of Stage 1004 at MSFC, will later be returned to Huntington Beach:

Model DSV-4B	Nomenclature	Units Required
300	Transporter	1
301	Cradle Kit	1
305	Tool Kit	1
307	Handling Kit, S-V Aft Interstage	1
352	Handling Kit, S-IB Aft Interstage	1

9.1.1.4 Aft Interstage Storage

The following GSE is required to place seven Saturn IB aft interstages in storage at Michoud:

Model DSV-4B	Nomenclature	Units Required
352	Handling Kit (Constant Aft Interstage)	4
1892	Constant Aft Interstage Cover	4*

9.1.1.5 APS Storage

The following GSE is required to handle and prepare for storage, fourteen Saturn IB APS Modules at STC M&A Building:

Model DSV-4B	Nomenclature	Units Required
344	Handling Kit, Attitude Control Module	3
1876	Handling Dolly, APS Module IB	2

*The aft interstage covers will be used in shipment of the interstages from Huntington Beach to Michoud. Prior to placing the aft interstages into long term storage, the covers will be removed and stored with other IB GSE at Michoud.

Since only four pedestals of Model 1892 are required for the indoor storage of each aft interstage, the unused pedestals will be placed into storage along with the other IB GSE.

9.1.1.6 Long Term Storage Kits

Models DSV-4B-797 and DSV-4B-789 will each consist of translucent covers fabricated from Weblon, or its equivalent. The covers will enclose the entire stage including the J-2 engine, and will be suitable for use with either the S-IVB/IB or S-IVB/V configuration. The covers will be sealed to the floor with weights contained in the edge of the covers. The other major components of the long term storage kits include a recording instrument capable of sensing temperature and humidity, and providing a permanent continuous record thereof; a regenerative dehumidifier which will deliver filtered air to the storage enclosure; and the supply and return ducts.

Model DSV-4B-799 will consist of an aft cover adapter to accommodate storage in Tower 7; a cover sling to facilitate the installation and removal of the covers; and the accessories peculiar to HB for long term stage storage. Model DSV-4B-800 will consist of an aft cover adapter insert to accommodate one of the two stages stored vertically at STC; cover slings to facilitate installation and removal of the covers; and the accessories peculiar to STC for long term stage storage.

The long term storage kits and the accessory kits will provide a suitable environment for the stages during storage. The stage ambient conditions inside the cover will be limited to a maximum of 40 percent relative humidity with the cover closed and the system operating.

9.1.2 Sacramento Test Center

The planned storage of five stages at STC consists of storing two stages vertically and one horizontally in the north bay of the VCL. The other two stages will be stored horizontally in the center section of the Manufacturing Support Building. The GSE and NDSE required for horizontal storage in the VCL north bay (one stage) and in the Manufacturing Support

Building (two stages) is shown in Figure 4. The GSE and NDSE required for vertical storage in the VCL north bay (two stages) is shown in Figure 5.

The APS Preservation Kit, Model DSV-4B-366 (S-IVB/IB) and Model DSV-4B-367 (S-IVB/V), two per stage, is required to accommodate the APS modules stored at STC. The APS modules will be stored indoors.

9.1.3 Huntington Beach

Existing facilities at HB can only accommodate the long term storage of one stage. The stage will be stored vertically in Tower 7. The GSE and NDSE required to support this storage is shown in Figure 6. Horizontal storage of an additional stage is possible if facility utilization at HB permits.

9.2 Additional Storage Equipment Requirements

New requirements to support stage storage at HB consists of a six-foot high chain link fence at ground level and the fencing and gates necessary to secure the common stairway between Towers 7 and 8 and the fencing necessary to enclose the area approximately 500 to 600 square feet for storage of ancillary hardware.

New requirements to support stage storage at STC consists of erecting portable, or easily removable, six-foot fences around the stages stored in the center section of the Manufacturing Support Building and the fencing necessary to restrict access to the stages stored in the north bay of the VCL.

A portable emissometer (infrared) and a solar absorptance device will be required to perform a post storage inspection of optical properties on thermally-controlled surfaces.

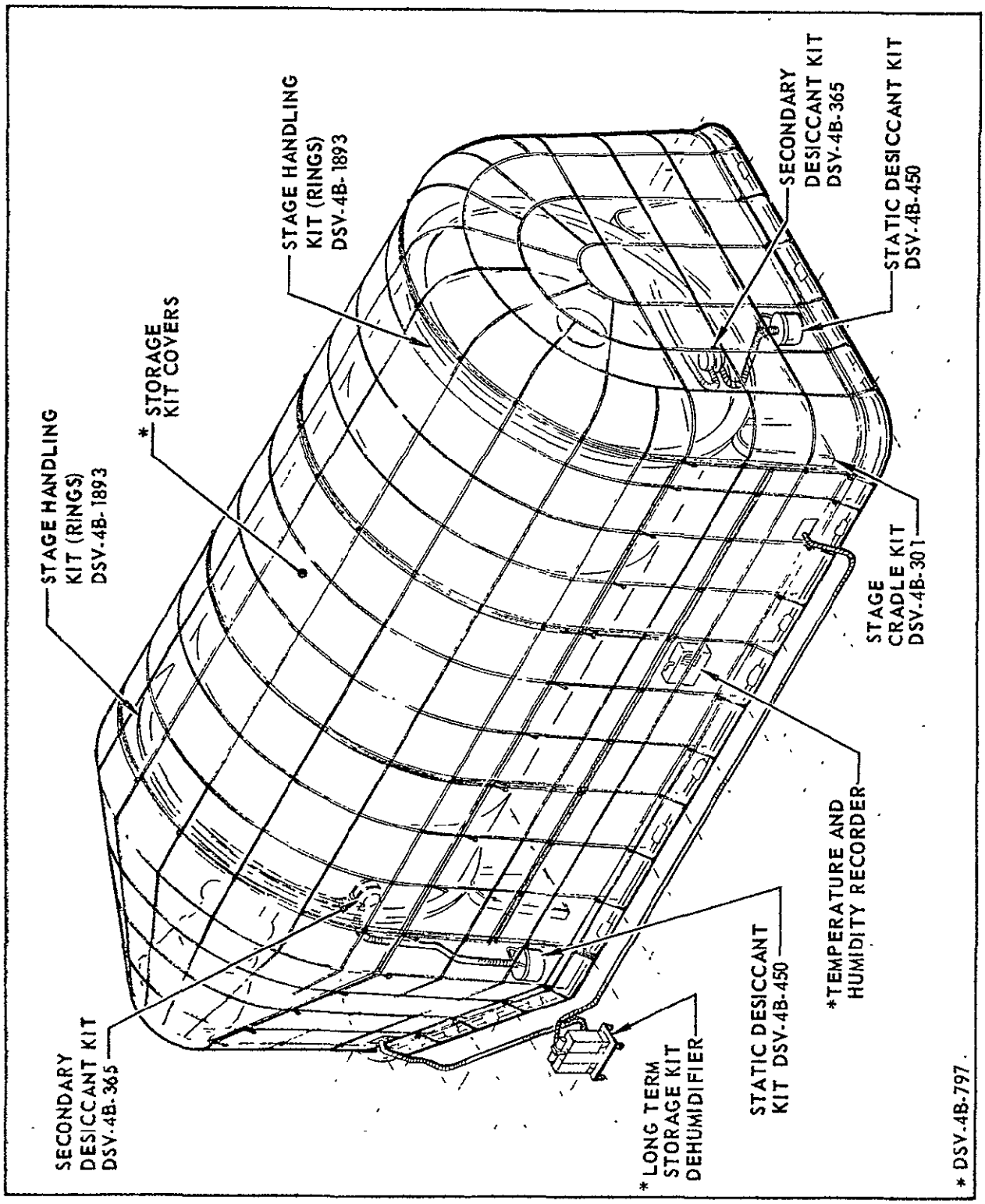


Figure 4. GSE and NDSE Requirements - Horizontal Storage STC - Typical

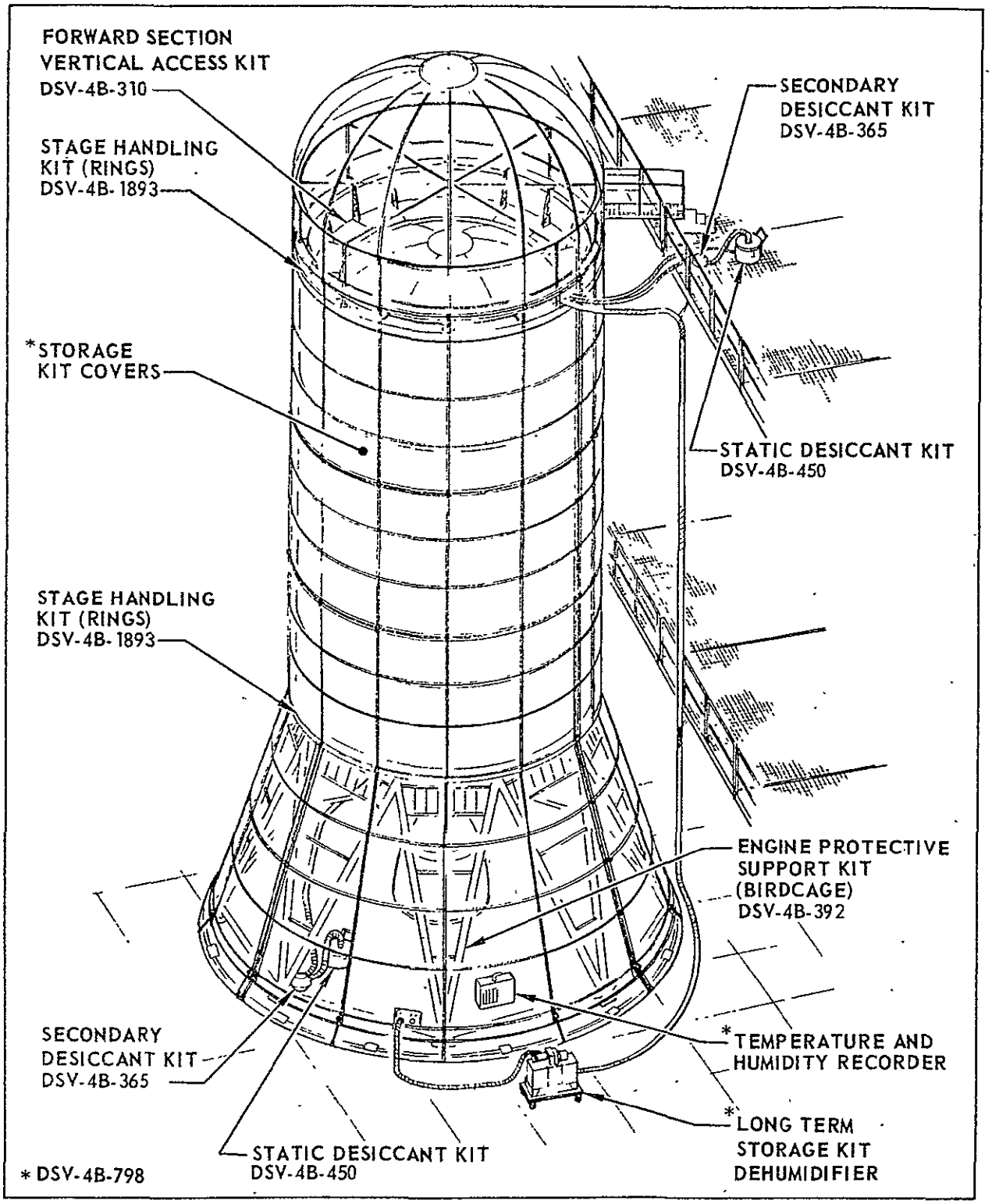


Figure 5. GSE and NDSE Requirements - Vertical Storage STC - Typical

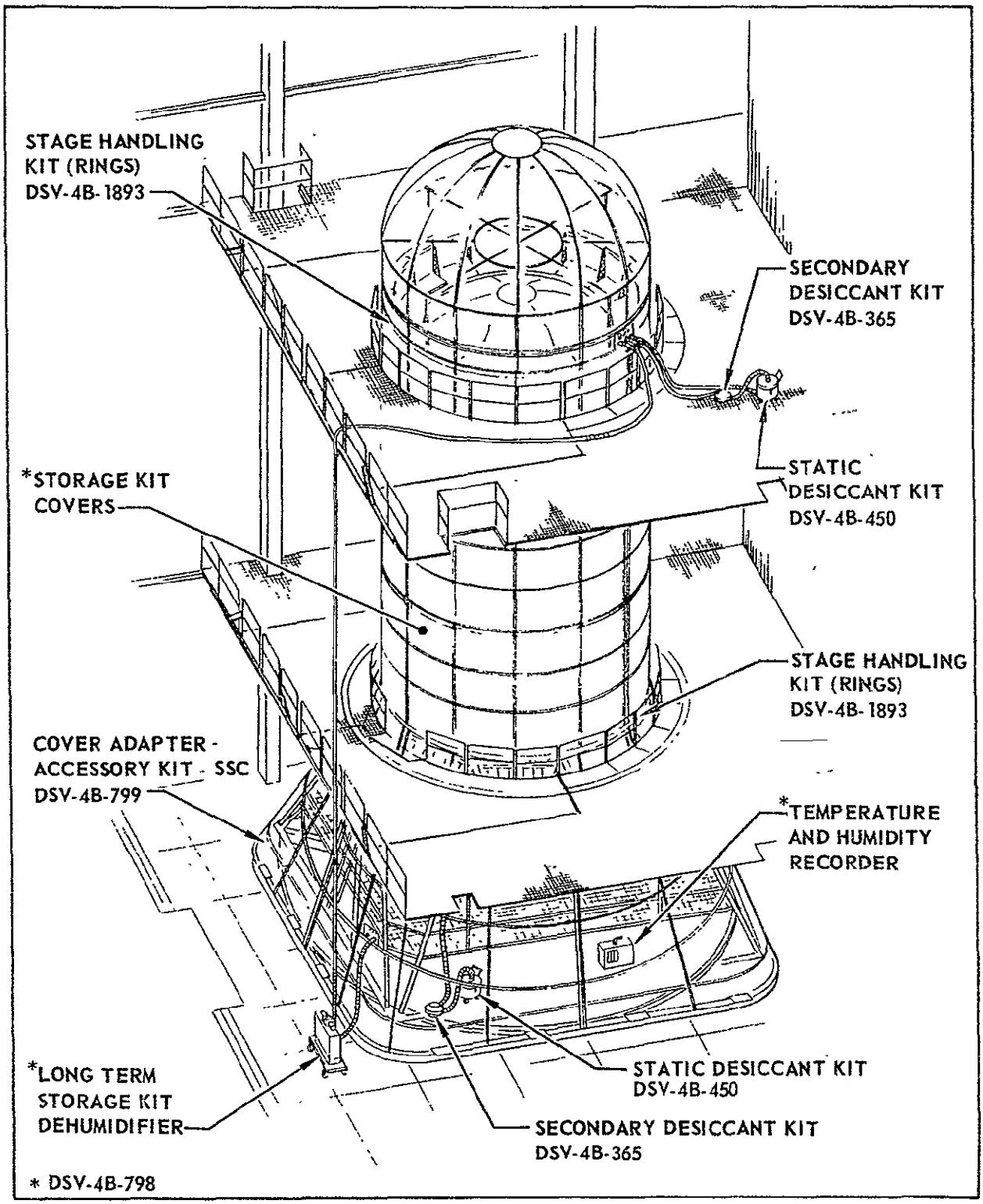


Figure 6. GSE and NDSE Requirements - Vertical Storage HB

Existing capabilities will accommodate the storage of ordnance (explosive kits) equipment for four stages. It is recommended that temporary bunkers be authorized to store the ordnance items for additional stages, as required.

10. PRESERVATION AND PRESTORAGE REQUIREMENTS

10.1 General

The preservation and prestorage requirements for stage storage are predicated on pre-determined storage periods. If a stage is to be stored for less than six months, preservation methods and procedures that are used for normal stage handling and protection during the manufacturing, test, and turnover cycle will be sufficient to properly protect the stage and stage hardware. If a stage is to be stored longer than six months, it must be preserved and stored under environmentally-controlled conditions.

The LOX and LH_2 tanks and stage systems will be purged with dry nitrogen to remove moisture prior to installation of the environmental control systems. After purging, each system shall be equipped with desiccant and humidity indicators prior to closing the system. The tanks shall be equipped with a static breathing external desiccant system. Dynamic environmental control shall be used to protect the forward skirt area, center section, aft skirt area, J-2 engine, and aluminized mylar insulation on the forward and aft tank domes.

10.2 Stage, Systems, and Equipment

10.2.1 Stage Surfaces

Prior to storage, the external surfaces of the stage will be cleaned of
R1 visible foreign debris. Stored stages shall be protected with finish specification F-289 prior to storage.

10.2.2 Propellant Tanks

The LOX and LH_2 tanks will be purged with dry nitrogen to remove moisture prior to installation of the environmental control system. After purging,

the propellant tanks shall be equipped with a free breathing external desiccant system in accordance with Specification MIL-D-3716. If during storage, a dewpoint condition is unavoidable, a dry GN_2 purge or blanket purge for the tanks will be provided.

10.2.3 Pneumatic System

The stage pneumatic systems shall be charged with a low positive pressure, where practical, with GN_2. Vent ports shall be capped where fittings are provided. Once placed in storage, no additional checks or repressurizations shall be performed until storage is terminated.

10.2.4 Hydraulic Systems

The hydraulic system shall be stored wet, unbroken, and under positive pressure in accordance with the requirements of Standard MSFC-STD-492. The oil side of the hydraulic system will be filled to a maximum volume to ensure that the system seals remain wet during storage. The servo-actuators shall be stored with the mid-stroke locks installed.

If the stage is placed in storage after manufacture, but prior to VCL checkout activity on the hydraulic system, the stage must be placed in the vertical position in order to fill, flush, and bleed the hydraulic system; this prevents air being trapped in the system. The hydraulic pumping unit is used to fill and flush the on-board hydraulic system. The fluid is circulated at 300 psig for 30 minutes during which time the system is checked for leakage. After the 30 minute period, and still pressurized at 300 psig, 200 ml of fluid is bled from each of the bleed ports on the on-board system. Two fluid samples are obtained, one from the reservoir bleed port and the other from the hydraulic pumping unit return sampling port. Samples must meet the cleanliness level requirements of Drawing 1P00068; then, the on-board accumulator is charged with dry GN_2 to 50 psig.

If the stage is placed in storage any time after VCL checkout at HB, the following items should be accomplished; the stage may be in either

the horizontal or vertical position. Using the hydraulic pumping unit, the fluid in the on-board hydraulic system is circulated at 300 psig for 15 minutes during which time the system is checked for leakage. Two fluid samples are obtained, one from the reservoir bleed port and the other from the hydraulic pumping unit return sampling port. Samples must meet the cleanliness requirements of Drawing 1P00068; then, the on-board accumulator is charged with dry GN_2 to 50 psig.

10.2.5 J-2 Engine

The J-2 engine shall be stored attached to the stage if the stage assembly has been completed prior to storage. The engine shall not be removed from a stage for purposes of storage. Preparation for storage of the J-2 engine will be accomplished in accordance with the instructions in J-2 Rocket Engine Maintenance and Repair Manual, R-3825-3, Volume 1. Thermal insulation that is not permanently bonded in place shall be removed and stored separately. Protective closures shall be installed in the engine thrust chamber exit and drain line exits.

If an engine is to be stored separate from the stage, in addition to the foregoing requirements, protective closures shall be installed on all control, purge, electrical, and pump inlets.

10.2.6 Mechanical Components

All stage mechanical components shall be stored in the unloaded or at-rest-condition.

10.2.7 Electromechanical Components

All stage electromechanical and electrical components shall be stored in the de-energized condition.

10.2.8 Electrical and Instrumentation Components

R1 Black box components shall not be removed from the stage prior to, or during, storage. Pressurized black boxes shall not be depressurized for storage nor will they be monitored or repressurized during storage. All stage instrumentation components shall be dormant during storage. No stage component shall be used for sensing, monitoring, indicating, or

transmitting data relative to storage conditions. Unterminated wires will be stowed per instructions contained in pertinent Engineering drawings. Unmated connectors will be protected with standrad dust caps. All stored stages will be grounded.

10.2.9 APS Modules

The APS modules with the APS preservation kits installed will be stored in the M&A Building. The APS propellant system and ullages will be pressurized with blanket pressure.

10.2.10 Age Sensitive Material

Records of age sensitive material shall be maintained in accordance with Standard MSFC-STD-105. Age sensitive materials installed on the stage that have exceeded their expiration dates shall not be disturbed during storage.

Replacement or refurbishment of these items shall be delayed until reactivation of the stage.

10.2.11 Component Covers

All component covers, including removable insulation, used for transportation or protection while the stage is being serviced or modified shall be removed prior to storage. This does not include electrical plug covers, pneumatic system closures, or the engine protective closures.

10.2.12 O_2H_2 Burner

The O_2H_2 burner shall be purged with dry GN_2 or helium to 40 percent relative humidity and desiccated prior to storage.

10.3 Ancillary Hardware

10.3.1 Aft Interstage

The aft interstage structures will be placed upon a support fixture which assures support at a minimum of 24 inches above the ground. When stored outdoors, the support fixture will contain tiedown provisions and allow entry to the interior of the structure. In addition, a waterproof shroud

will be used to cover the interstages. The shroud will be placed and tied so that it will not trap water or allow wind whipping, and shall permit free air circulation. When stored inside, a dust cover only will be required.

Attachment of the aft interstage enclosures will be performed in a manner which will have no detrimental effect upon the exterior finish. Adhesive tape shall not be applied to the exterior surfaces. The protective covers must be installed to preclude the cover touching any portion of the Korotherm insulation to prevent damage from direct moisture contact which might result from condensation.

Electrical connectors shall be provided with standard dust caps.

The forward and aft interface faying surfaces will be protected through the application of zinc chromate primer. Chromate primer will be removed upon reactivation of the interstages.

10.3.2 Retro and Ullage Rockets

The retro and ullage rockets will be stored in their respective shipping containers. Desiccation and preservation, as provided by shipping containers, will be maintained during storage.

11. PERIODIC INSPECTION AND SERVICING

The periodic inspection and servicing requirements to support long term, environment-controlled stage storage will be limited to the inspection and monitoring of stage and stage equipment desiccants, servicing and replacing desiccants, purging activities, preventive maintenance of supporting GSE and NDSE, and maintenance of records, logs, and forms for stored equipment.

11.1 Storage Maintenance Program

A storage maintenance program will be implemented and controlled to ensure

that all stored stages, aft interstages, ancillary hardware, and supporting GSE and NDSE are maintained utilizing applicable handling and checkout drawings and maintenance procedures.

11.2 Maintenance Drawings

Handling and checkout drawings and maintenance procedure drawings will contain the maintenance requirements, supporting reference data, and the procedural steps necessary to accomplish maintenance. Safety and security requirements will be included, as applicable. The drawings will be upgraded, as required, to reflect current maintenance data.

11.3 Engineering Responsibility

Engineering responsibility for all maintenance activities of stages in storage shall be vested in an approved representative of the Structural/ Mechanical Branch of Engineering.

11.4 Limited Life Items

Limited life items (i.e., age sensitive and time/cycle significant) that have exceeded their expiration date will not be replaced during storage but shall be removed, recertified, and reinstalled or replaced, as necessary, to return stage to baseline configuration during the post storage refurbishment period.

A listing of limited-life items for a specific stage shall be provided in accordance with MSFC-DRL-021, Line Item 102, and will be documented in the End Item Log Books on applicable limited life log forms.

12. QUALITY ASSURANCE REQUIREMENTS

The Quality Assurance effort associated with stage storage will be implemented in accordance with applicable provisions of the Saturn S-IVB Quality Program Plan, Douglas Report SM-41891.

This effort takes into consideration all phases of end item monitoring, surveillance, and inspections required to assure maximum maintenance of stage quality and integrity. These tasks will include:

a. Review of released storage handling and checkout drawings (H&COs) and maintenance procedures (MP) for determination and preplanning of inspection points.
b. Release of special charts and documentation requirements.
c. Verification of implementation and compliance with storage, maintenance, calibration, and retest requirements.
d. Reporting of any nonconformances detected during the storage period by the Failure and Rejection Report (FARR) system.
e. Incorporation of verified documentation into stage log books, Narrative End Item Reports, or other reports, as appropriate.
f. Verification of incorporation and maintenance of limited life item data collection forms in end item log books.

12.1 Storage Inspection

Inspections to be performed in preparation for storage and during the storage period will be determined by a comprehensive review by Quality Engineering of released Development Engineering requirements and storage and maintenance instructions. The inspection points determined necessary during this review are incorporated into the procedures or instructions, as appropriate. The released instructions include:

a. Inspection location and instructions.
b. Frequency of inspections.
c. Verification and documentation instructions.

Typical examples of the type of inspections performed include monitoring desiccant systems, monitoring preventive maintenance of storage GSE, and assuring compliance with Development Engineering instructions for the removal and separate storage of parts and components, as required.

12.2 Surveillance

Control at defined points is supplemented by surveillance of all storage phases, i.e., preparation for storage, storage, and removal from storage. Dirt, corrosion, expiration of limited life items, and contamination of the stage or its environment are reported and appropriate corrective measures are initiated.

12.3 Test and Checkout Inspections

To assure that no degradation has occurred during the storage period, testing is accomplished at the conclusion of the storage period to verify system integrity and conformance. Test requirements established by Development Engineering are conditions of acceptance and, therefore, are quality control requirements. The test procedures (H&COs) provide the means by which the test requirements can be verified. The procedures specify the test objectives, environments, measuring and test equipment to be used, the exact test methods and detailed operations to be performed by the test operator, the data to be recorded (including time and cycle data), and the acceptance parameters.

Reliability Assurance is responsible to verify the accomplishment of these tests, assure that only certified equipment is used, verify the test data, and signify conformance to the test procedures by stamping the appropriate documents which then become the inspection records.

12.4 Final Inspection

Final inspections prior to release of the stage from storage include:

a. A review of accompanying manufacturing and inspection records to assure inspection completeness and nonconformance clearance.
b. A verification that required logs, data, evidence of inspection, and test documentation accompany the end item.
c. A check for obvious damage, omissions, and oversight.

d. A review of limited life item data to assure adequate remaining useful life through mission requirements.

12.5 Shipping Inspection

Reliability Assurance will ensure that the stage, when shipped following storage, conforms to design requirements, and that evidence of product conformance and configuration, including applicable documentation, is complete and is included with the end item for shipment. Reliability Assurance also ensures that the end item is properly packaged for shipment per released Engineering instructions.

13. SPARE PARTS REQUIREMENTS

13.1 Stage Requirements

An adequate spare parts program will be maintained throughout the S-IVB stage storage period to support stage refurbishment, retest, and configuration modifications.

The spare parts needed to support refurbishment requirements for stages removed from storage are selected based on program need dates and lead times for each stage. These spares will be controlled independent of the Contractor's work-in-process inventories.

A master schedule which contains spare part requirements will be prepared and maintained for the removal/replacement of expired limited life items in the stages.

13.2 Long Term Storage

In the event of long term storage of the stages, inventories of limited life items will be augmented to satisfy the requirements of refurbishment. Selection of these inventory items will be based primarily upon the number of stages in storage, the length of the storage period, post-storage operation and mission requirements, and manufacturing and procurement lead times.

13.3 Provisioning

After spare parts requirements are identified, an analysis will be performed to determine what existing MRSI assets are available from the Test Center inventories that can be transferred to a controlled stockroom in support of stage refurbishment. In the event this anlaysis identifies new and/or additional replenishment spare part requirements, these items will be procured by separate Change Order action, independent of the Stage Logistics Program Plan.

A controlled stockroom and inventory procedures will be established to manage procured/refurbished assemblies, parts, and materials.

13.4 Ancillary Hardware Requirements

Ancillary hardware, such as retrorockets, and ullage rockets, shall be reviewed with respect to their shelf life expectancy and will be stored at appropriate locations. Items with short life expectancy will be rescheduled to preclude the end of the shelf life occurring during the storage period.

13.5 GSE and NDSE Requirements

The spare parts requirements for GSE and NDSE (procured under Contract NAS7-101) utilized for stage storage will be selected in accordance with the maintenance procedure drawings and design engineering recommendations. The requirements necessary to support storage GSE and NDSE will be allocated to the applicable storage site.

The management of GSE and NDSE spare parts will be in accordance with the S-IVB Stage Logistic Program Plan, Douglas Report SM-46669. This will include areas such as full utilization of test site assets, common storage areas, and central inventory records.

14. STAGE REMOVAL FROM STORAGE

14.1 General

New procedures and updated existing procedures will be provided to remove

the storage GSE and NDSE. It will require approximately two calendar days to remove the storage equipment.

14.2 Stage Removal Procedures

Typical procedures to be provided will include, but not be limited to, the following:

Procedure	Use
Stage Installation and Removal - Storage Position, Horizontal	Required to remove stage from storage and place on transporter
Stage Installation and removal - Storage Position, Vertical	Required to remove stage from storage and place on transporter
Low Profile Stage Storage	Required to remove stage from low profile storage
Storage Desiccant Installation Removal	Required to remove the special storage desiccant monitoring equipment
Stage Transportation, Transporter	Required to move stage on stage transporter

15. POST-STORAGE INSPECTION

15.1 General

Post-storage inspection procedures for the stage and stage hardware are based on present knowledge of those areas most susceptible to damage or deterioration during or upon removal from storage. Specific time intervals for inspection will be determined and correlated to the particular areas to be inspected or hardware to be inspected.

15.2 Inspection Considerations

If a stage and stage hardware have been stored for less than six months, existing inspection methods and procedures that are normally required for stage handling and protection during manufacturing, test, and turnover will be sufficient to assure that the stage will be maintained in a flight operational reliable condition.

When a stage and stage hardware have been removed from environmentally-controlled storage (six months or more), specific post-storage inspection procedures will be provided. Post-storage inspection will identify requirements for servicing, corrective actions, retest, and other activities, as required, to return the stage and stage hardware to a flight operational reliable condition.

15.3 Post-Storage Inspection Requirements

Inspection requirements for a stage and stage hardware that have been stored for periods exceeding six months will include, but not be limited to, the following:

a. A complete survey of the stage for corrosion. Inspect paint and ablative coating for deterioration, and/or debonding. Repairs will be made per Finish Specification F-289, and painting and markings drawings 1A39311 or 1A39315. Ablative coating repairs will be accomplished as required by installation drawings 1B54715, 1B64960, and/or 1B65223.

b. Inspect and measure optical properties of thermally-controlled surfaces (low emissivity surfaces, aluminized tape, paint exterior of LH_2 tank, exterior of APS modules, etc.) on the stage. Thermally-controlled surfaces and their emissivity requirements include the following:

S-IVB/S-IB Stage	Emissivity Reqmt (Except as Noted)
(1) Electronic Equipment Radiation Shield (Forward and Aft Skirts) . . .	= 0.3 or less
(2) Multiplexer (Aft Skirt)	= 0.1 or less
(3) Switch Selector (Aft Skirt)	= 0.1 or less
(4) LH_2 Tank Exterior (Solar Absorptivity)	= 0.4 or less

S-IVB/S-IB Stage	Emissivity Reqmt (Except as Noted)
(5) APS Exterior	
(a) Emissivity and Solar Absorptivity	= 0.3 or less
(b) Ratio of Solar Absorptivity to Emissivity	≤ 1.10
(6) Chilldown Inverter Aluminized Shroud	= 0.1 or less
S-IVB/S-V Stage	
(1) Electronic Equipment Radiation Shield (Forward and Aft Skirts)	= 0.3 or less
(2) Forward Tank Dome (Forward Skirt)	= 0.1 or less
(3) LH_2 Tank Exterior (Solar Absorptivity)	= 0.4 or less
(4) Aft Tank Dome (Aft Skirt)	= 0.1 or less
(5) Multiplexer (Aft Skirt)	= 0.1 or less
(6) Switch Selector (Aft Skirt)	= 0.1 or less
(7) APS Exterior	
(a) Emissivity and Solar Absorptivity	= 0.3 or less
(b) Ratio of Solar Absorptivity to Emissivity	≤ 1.10
(8) Chilldown Inverters Aluminized Shroud	= 0.1 or less

In addition to the post-storage inspection requirements listed, the following inspection requirements will be necessary for stages stored for twelve months or more. Items a., b., and c. will be required if an unsatisfactory condition is encountered upon inspection of the first stage removed from storage.

a. Inspect LH_2 tank internal insulation for debonding.

b. Inspect cold helium tank straps inside the LH_2 tank for correct tension loads as required on Installation Drawing 1B57523.

c. Inspect all exposed metal surfaces in the LH_2 and LOX tanks for corrosion. Verify electrical continuity on all points of electrical bonding (PU and Instrumentation Probes).

d. Inspect and repair aluminized mylar on the forward and aft domes of the stage to conform with Installation Drawings 1A93131, 1B65892 or 1B65389, and 1B66486.

e. Verify electrical continuity of the forward skirt, aft skirt, main tunnel, and auxiliary tunnel to the LH_2 and LOX tanks. The DC resistance across the joints shall not exceed 0.001 ohm.

f. Inspect ambient helium tank straps on the thrust structure for correct tension as described in Installation Drawings 1B39870 and 1B43985.

g. Check stage log books to determine configuration modification requirements, and initiate appropriate action, as required.

h. Inspect forward and aft skirts interface attach rings and refinish as required by Finish Specification F-289, and Installation Drawings 1A39264, 1B29835, 1A39310, and 1B29324.

i. Inspect forward and aft skirt interface surfaces of the attach rings per Installation Drawings 1A39310, 1B29824, and 1A39264 or 1B29835 for electrical bonding. Prepare surfaces per Finish Specification F-289.

j. Inspect aft interstage interface surfaces of the attach rings per Installation Drawings 1A71608, 1B56533 or 1B29836 for electrical bonding. Prepare surfaces per Finish Specification F-289.

k. Inspect all rubber or elastomer vibration isolators for debonding; all metallic vibration isolators for corrosion.

16. POST-STORAGE STAGE REFURBISHMENT AND CONFIGURATION REQUIREMENTS

16.1 Refurbishment

Items which required special storage preparations and/or preservation will be returned to their respective flight configuration.

Pressurized "black boxes" will be depressurized, purged, and repressurized if stored for a period longer than six months.

Limited life items will be analyzed to determine (1) whether the item is technically refurbishable (considering design characteristics, material composition, and existing vendor and/or MDAC-WD facility technical capabilities); and (2) whether an item is refurbishable based upon the estimated refurbish cost versus the maximum allowable refurbish cost. This analysis will provide one of three dispositions:

a. Determination of items which can be refurbished by MDAC-WD.
b. Determination of items which must be refurbished by the vendor.
c. Determination of items which are not refurbishable, and which must be removed and replaced by flight qualified items.

Preplanned work orders will be prepared containing instructional information to accomplish the following:

a. Removal and replacement of non-refurbishable flight hardware items.
b. Removal and routing to vendor of flight hardware for refurbishment.
c. Removal and refurbish flight hardware by MDAC-WD. Activities to include the following:
    (1) List of detailed parts and materials to accomplish refurbishment.
    (2) List of special tools and test equipment.
    (3) Refurbishment location and manhours required.
    (4) Disassembly/assembly instructions, warnings, and cautions, as required.
    (5) Component test requirements.

d. Removal and recalibration of flight hardware identified in paragraph 17.

A review of stage log books will be performed considering storage, delivery, launch schedules, mission requirements, and expiration dates of limited life items to identify the items that must be removed on each stage.

A master schedule will be prepared and maintained for the removal of items in the stages that must be replaced, refurbished, or recalibrated.

A Program Change Proposal (PCP) will be submitted for customer approval to remove and replace applicable items in each stage, and to replace, refurbish, and/or recalibrate the removed items.

Spare parts selection and control will be in accordance with paragraph 13.3.

Upon customer approval of the PCP, preplanned work orders will be released to remove, replace, refurbish, and recalibrate applicable items. Liaison will be provided for MDAC-WD/vendor refurbishing efforts to facilitate problem resolution and ensure compliance to stage delivery schedules.

16.2 Stage Configuration Requirements

The stage and stage hardware will be modified to the latest stage configuration requirements, as noted in the stage log book.

17. POST-STORAGE STAGE CALIBRATION, RETEST, TEST, AND RECERTIFICATION REQUIREMENTS

17.1 General

The basic criteria for test, retest, calibration, and recertification of the stage is that regardless of when the stage entered storage, the same degree of flight reliability established in normal schedule phasing will

be re-established following stage storage. Figure 1, S-IVB Stage Storage Work Flow, describes the typical activity and time relationships required to reactivate and recertify stages stored prior to static firing and following static firing. A stage that has been stored will be routed through any remaining checkout cycle after storage, regardless of the storage period. However, the requirements for a stage stored less than six months should require a very minimal checkout during turnaround. Stages that have been stored for six months or more will require as a minimum an All-Systems Test or an Integrated Systems Test following removal from storage. The depth of subsystem tests to be performed prior to the All-Systems Test or Integrated Systems Test will be determined prior to removal from storage, and will be detailed in a change to the appropriate Stage End Item Test Plan.

Most of the retest effort will consist of pretest preparations of the checkout system, both hardware and software. Once the checkout system configuration has been properly established for any particular subsystem or system test, a much smaller effort is required to extend the checkout coverage to all other tests.

In establishing retest requirements, it is assumed that the presently utilized checkout facilities and GSE will be available at HB and STC. It is further assumed the method of test operation will remain the same; modification to checkout facilities, GSE, or mode of operations can grossly affect the span of time necessary for pretest preparation, as well as performance of the test itself.

Retest requirements for stages following storage at HB will be based on two premises: (1) the stage will be shipped to STC for static firing; (2) the stage will be shipped directly to FTC following storage. If the stage is to be shipped to STC, it will first be refurbished as required at HB prior to shipment. If any system, or subsystem, has been invalidated due to

storage or refurbishment, the stage will be retested prior to firing at STC to revalidate the system. The validation tests will be performed either at HB prior to shipment, or at STC upon arrivel. STC checkout for stages stored at HB include pre-firing, firing, and post-firing checkout.

If the stage is to be shipped directly to FTC after storage at HB, it will first be tested in the VCL or Beta stands to prove stage operational readiness. These tests will include pre-fire test, such as propulsion and leak check tests, and any subsystem tests necessary to revalidate a system or subsystem that has been invalidated during storage or refurbishment. An All-Systems Test also will be included. When delivered to FTC, the stage will be in a flight-ready condition.

Retest requirements for stages following storage at STC will be based on the following two premises: (1) the stage will be stored prior to firing; (2) the stage will be stored following static firing. If a stage is stored prior to firing, it shall be refurbished as required, following removal from storage, and then shall undergo a complete test firing. These tests will include pre-fire checkout and all tests required to revalidate any system or subsystem invalidated during storage or refurbishment. Following firing, a complete post-fire test shall be conducted to assure that the stage will be in a flight-ready condition upon arrival at FTC.

If the stage is fired prior to storage at STC, it shall be refurbished, as required, upon removal from storage, and then checked out and tested in either the Beta Test Stand or in the VCL. The tests necessary to assure flight readiness will include critical subsystem tests, subsystem tests necessary to validate systems or subsystems which were invalidated during storage or refurbishment, and an All-Systems Test, which will assure that the stage will be in a flight-ready condition upon arrival at FTC.

A lead time will be required to re-establish the checkout system for retest of operational stages. This includes GSE configuration and recertification, release of stage test procedures and support software, and provision of magnetic test tapes. Any major modifications to the stage which significantly affects the checkout procedures is considered beyond the scope of this plan.

17.2 Calibration Requirements

The following calibration requirements will be accomplished upon removal of a stage from storage, regardless of the storage period:

a. A random sample of electrical bonded surfaces shall be measured to determine compliance with their respective installation drawing requirements.

b. Ambient resistance of all temperature transducers will be measured to determine compliance with their respective installation and specification control drawings.

Additional calibration requirements by storage periods are listed in paragraphs 17.2.1 through 17.2.3.

17.2.1 Transducer Calibration - Six to Twelve Months

If the stage has been stored from six to twelve months, the test/retest procedures must verify proper output of the following transducers to normal checkout tolerances at a pressure approximately 75 percent of full scale range:

1A68551	Transducer, Pressure	1B32291	Transducer, Pressure
1A72913	Transducer, Pressure	1B39293	Transducer, Pressure
1A72914	Transducer, Pressure	1B40242	Transducer, Pressure
1A88035	Transducer, Pressure	1B43324	Transducer, Pressure
1B97442	Transducer, Pressure	1B53573	Transducer, Pressure
1A31356	Transducer, Pressure	1B53574	Transducer, Pressure
1B31377	Transducer, Pressure	1B65841	Transducer, Pressure
1B31413	Transducer, Pressure	1B43320	Transducer, Pressure

17.2.2 Transducer Calibration - Twelve to Twenty-Four Months

If the stage has been stored from twelve to twenty-four months, in addition to complying with the requirements of paragraph 17.2.1, the following transducers must be removed from the stage and calibrated:

1A88769	Transducer, Accelerometer
1B38508	Transducer, Pressure

17.2.3 Transducer Calibration - Twenty-Four to Thirty-Six Months

If the stage has been stored from twenty-four to thirty-six months, in addition to complying with the requirements of paragraphs 17.2.1 and 17.2.2, the following transducers must be removed from the stage and calibrated:

1A68707	Transducer, Pressure	1A89104	Transducer, Pressure
1A68708	Transducer, Pressure	1A95763	Transducer, Pressure
1A68709	Transducer, Pressure	1B27508	Transducer, Pressure
1A88599	Transducer, Pressure	1B29029	Transducer, Pressure
1A88852	Transducer, Pressure	1B51689	Transducer, Pressure

17.3 Retest Requirements

17.2.1 Test/Retest Requirements - Less Than Six Months Storage

Any modifications made to reinstate the stage to its base-line configuration must be retested consistent with the degree of modification. In addition, certain required tests must be accomplished to verify stage operation. These tests will be detailed in the applicable End Item Test Plan.

Transducer serial numbers for all critical measurements, i.e., red line, blue line, EDS, and flight control parameters, will be verified against the calibration book.

17.3.2 Test/Retest Requirements - Six to Thirty-Six Months Storage

After a stage has been removed from storage and refurbished to a flight operational reliable condition, the tests and checkout to be accomplished will be detailed in the applicable Stage End Item Test Plan. Checkout

and test requirements for individual stages will be directed by Engineering Orders (EOs) to the End Item Test Plan(s), and Drawings 1B66532 (S-IVB/S-IB Stage) and 1B66684 (S-IVB/S-V Stage).

17.3.2.1 Stages Stored Prior to Static Firing

After removal from storage at either HB or STC, the stage will be refurbished to a flight reliable condition. This will include replacing or retesting expired limited life stage installed items. The stage checkout and tests to be accomplished will be essentially those that are presently performed during normal phasing (pre-fire checkout, static firing, and post-fire checkout operations). The detailed tests for these operations are contained in the applicable End Item Test Plan and Static Firing Test Plan.

17.3.2.2 Stages Stored After Static Firing

After removal from storage and refurbishment to a flight reliable condition at STC, the stage checkout will consist of the post-fire checkout detailed in the applicable stage End Item Test Plan.

These tests will include, but not be limited to, the following listing. Tests identified by an asterisk (*) will be accomplished only if the stage has been stored for more than six months. Other tests listed are to be accomplished after any period of storage.

Set-Up Operation and Securing Thermoconditioning
Umbilical Interface Compatibility
Stage Power Setup
Stage Power Setoff
Signal Conditioning Setup
*Point Level Sensor Checkout
Cryogenic Temperature Sensor Calibration
*Power Distribution
*DDA Calibration

DDAS Automatic Checkout

*T/M and Range Safety Antenna Checkout

*Range Safety Receiver Automatic Checkout

*Range Safety Automatic Checkout

*PU Calibration

*PU Automatic Calibration

*EBW Subsystem

Engine Alignment (if actuators are replaced)

Hydraulic Setup and Operation

Hydraulic System Operation and Securing

*Hydraulic Automatic Checkout

*Propulsion System Leak Checks

Propulsion Automatic Checkout

Manual Control Checks

Tank Blanket Pressure

Pre-Ship Purge

Vacuum Pumping

Environmental System Installation, Air Carry

Weigh and Balance Preparation

Weigh and Balance

Structural Inspection

All-Systems Test

Special Cables and Vehicle Simulators Installation

During normal checkout, the APS modules are mated to the stage after stage acceptance firing, and APS/stage tests are performed; however, if the stage is stored prior to these tests being run, they must be accomplished after termination of storage. These tests include the following:

APS Transport and Handling

APS Interface Compatibility

APS Checkout

APS Automatic Checkout

17.4 Additional Stage Test/Retest Considerations

The following items will be removed from a stage that has been stored for a period of twenty-four to thirty-six months, and will be verified by the equivalent of their respective product acceptance tests:

1A68085-505 E/I Switch, 300 Amps	1A59358-527 PU Assembly
1A74488-503 APS Potentiometer	1A59358-529 PU Assembly
1A88061-1 50 Amp Switch	1B67116-1 PU Assembly
1A59358-523 PU Assembly	1B67116-501 PU Assembly
1A59358-525 PU Assembly	

An EMC analysis will be performed on the telemetry data compiled during the All-Systems Test to demonstrate that the Data Acquisition System is electromagnetically compatible with other stage hardware in respect to conducted and radiated interference. The data will also be reviewed to ensure that all systems on the stage performed within the limits observed on EMC test data taken at an earlier time.

To facilitate the ability to provide the required test and support software following long term storage, it will be necessary to formalize some of the present retention schemes.

17.5 Recertification Requirements

The following procedures are representative of those required to recertify a stage that has been stored for six months or more to a flight reliable condition. A typical stage reactivation schedule is shown in Figure 7.

PROCEDURE	USE
Static Desiccant System	Required to desiccate stage during checkout
Structural Inspection, Stored Stages	Required to verify the structural integrity of stage following storage
DDAS Ground Station, Automatic	Required to verify proper operation of ground station prior to use

PROCEDURE	USE
Hydraulic Setup & Operation, Pre-Fire - Test Stand	Prepare hydraulic system for verification
Hydraulic Operations and Secure - Post-Fire - Test Stand - SACTO	Securing the hydraulic system for verification
Safety Item Monitor	Required to verify proper operation of SIM
GSE Setup, VCL	Required to setup GSE and instrumentation
Ground Equipment Test	Required to verify proper automatic GSE functioning and patching
DER Verification	Required to verify proper operation of the DER
Stage Installation - VCL SACTO	Required to install stage in checkout position
Forward Skirt Access Kit, Vertical H&CO	Required to install access kit in forward dome area
Aft Umbilical Kit, VCL, SACTO, H&CO	Required to supply propulsion and electrical stage interface
Forward Umbilical Kit, VCL-SACTO, H&CO and Vehicle Test	Required to supply propulsion and electrical stage interface
Vehicle Test Preparations	Prepares stage propulsion system for test
Umbilical Interface	Required to verify safe application of power to the stage
Automatic Checkout Preparation	Necessary for special hookups of safing and special cables
Thermoconditioner Setup, Operation, & Securing, VCL, SACTO	Required to supply environmental control to the forward kit cold plate during "power-on" portion of stage checkout
Vehicle Manual Controls Checks	Manually verifies stage propulsion systems to be compatible with electrical GSE manual controls

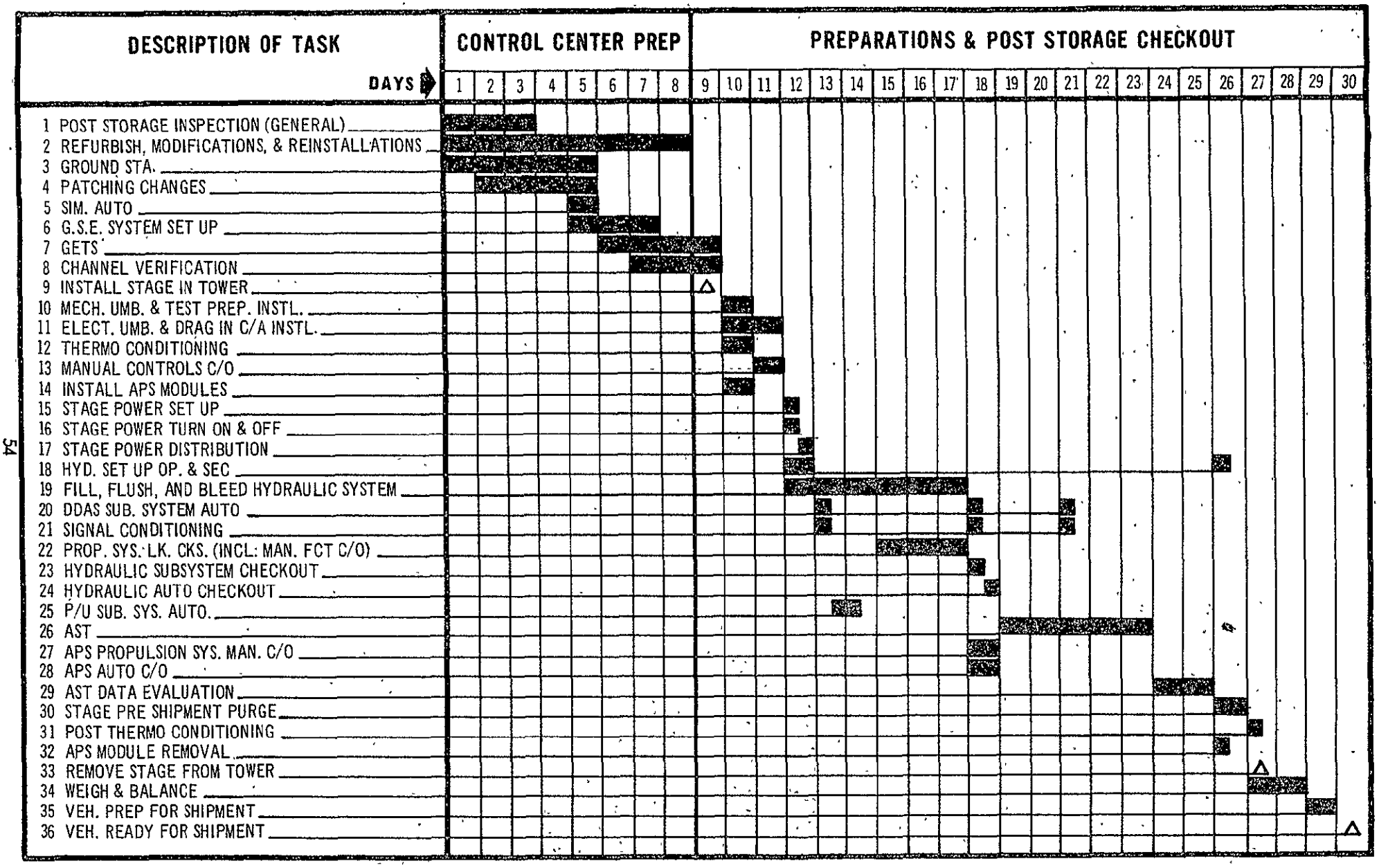


Figure 7. Typical Schedule for Stage Activation

PROCEDURE	USE
APS Transportation & Handling, VCL S-IVB/IB	Installs and removes APS's in the VCL
Stage Power Setup	Required to apply power to the stage
Stage Power Turnoff	Required to verify proper stage condition when power is removed from the stage
Power Distribution	Required to verify operation of the power distribution system
Setup, Operation & Securing - VCL - Hydraulic System	Required to operate stage hydraulic system and secure for shipment to FTC
DDA Subsystem Automatic	Required to provide channel by channel data acquisition system verification
Signal Conditioning Setup	Required to setup stage signal conditioning units
Stage Propulsion System Leak Check	Required to check the stage propulsion system for leaks
Stage Propulsion System Test	Required to verify operation of the stage propulsion system
PU Automatic	Required to verify operation of the stage PU system
All-Systems Test	Required to demonstrate subsystem interface compatibility and total stage integrity
APS Propulsion System Checkout	Required to verify stage/APS interface compatibility
APS Test	Required to functionally verify the APS propulsion systems
Weigh & Balance	To determine the stage weight and center of gravity
Stage Preparation for Shipment (Including Preshipment Purge of LOX and LH_2 Tanks)	Adds desiccant equipment and environmental covers for shipment. Purge prevents interior tank and system surfaces from reaching dew points.

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